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Peter Lynds Criticism Of Physical Time

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This paper discusses the criticism of the modern concept of physical time given by Peter Lynds in a series of recent papers which have attracted considerable interest. The reader should consult the article on Peter Lynds at Wikipedia and his home page for the papers being discussed here. There is considerable hype associated with the publication of Lynds ideas. The Guardian, a British newspaper, comments as follows: "Those who had glimpsed Lynds' ideas - which a physics journal has agreed to publish - were predicting they would shake the science world to its foundations and would solve philosophical and mathematical conundrums that have puzzled the best minds for thousands of years. Some were already comparing the young author with Albert Einstein." In the following we will see that Lynds ideas were not revolutionary, and that his main contribution is to clarify the idea of physical time which has been the subject of misunderstanding within the physics community.

The substance of Lynds main claim, that there is no such thing as an instant of time, is nothing new. It is simply a modern twist on old ideas. The basic premise underlying physical time is contained in Aristotle's Physics, Book IV, chapter 11. That there is no such thing as an instant of time had been a subject of controversy long before it was discussed by Aristotle in Chapter 10, and this discussion reviews the basis for the philosophical arguments that there is no time, or that time is not "real". For this reason, Aristotle defines time mathematically as the number of motion in Chapter 11. This definition of physical time by Aristotle has been generally ignored in the modern era, but he clearly gives the foundation for the concept of physical time as a mathematical number. Aristotle has been ignored primarily because his concept of physical time is conflated with philosophical ideas about time, which are incompatible with it. Essentially Lynds paper repackages these same ideas in a more modern language and context of modern physics. But the basic ideas are not new.

In a paper published in 1987 in the book Bergson and Modern Thought, Milic Capek makes it clear that Henri Bergson had already rejected the idea of a physical instant of time. According to Bergson the very existence of time excludes the existence of instants: "Instant is what would terminate duration if the latter came to a halt, But it does not halt. Real time therefore cannot supply the instant; the latter is born of the mathematical point, that is to say, of space." According to Capek physiologists and philosophers rejected the concept of time instant, and that only the physicists accepted it because of the supposed infinite divisibility of time. We will see later that the problem arises from the choice of number system used to describe physical time. This follows from Aristotle's definition of time as the number of motion, but the question of which number system is to be used in this definition is a modern one. We will see from the following analysis that the problem arises from the different conceptions of mathematical time that can be mapped into or used to represent the concept of physical time.

As I understand him, Lynds is contending that the real number system is not the correct mathematical model for physical time. I do not disagree with this contention, but it would be helpful if stated directly. The denial that there is an instant of time needs to be clarified in my view, since it is a commonly used conception. When I make a measurement at a sports meet, the gun fires and the runner crosses the line. These are two instants of time.

Perhaps one should say they are instances of time expression as events, but the common meaning seems entirely adequate. So why do we need to change this understanding? This is not made clear in Lynds paper.

What I think is the problem, is the confusion of the mathematical model with physical reality. We have to express physics in terms of numbers to do calculations. These numbers have different meanings. A number can be a count of discrete objects, but then it is an integer. We can extend integers to rational numbers in order to represent physical quantities as continuous magnitudes such as weight, volume, distance, time. These continuous magnitude numbers are counts of magnitude units, which are standardized definitions. The fundamental question arises as to whether these magnitude measures must be continuous or discrete when the measure units are reduced in size. If we insist that the measure units can be made infinitely small, we encounter a paradox due to the substitution of the real numbers for the rational numbers. This turns out to be the crux of the difficulty.

Mathematics argues in favor of the infinite divisibility of magnitudes, and this is the basis of the real numbers, which is an extension of the rational numbers which are incomplete. But when we adopt the real numbers without understanding their limitations we raise issues which Lynds has discussed in his papers. One has to be aware of the fact that when using real numbers and the calculus of the real numbers, that difficulties can arise, as in the problem of the reality of an instant of time.

Lynds has been accused of not understanding the calculus. Lets review this question. It is a misunderstanding to suppose that in Riemannian integration that what is added up in an integral are infinitely divided magnitudes. This is not exactly true. In Riemannian integration, time is divided into a large number of small time durations, and as these are divided into smaller and smaller parts, the sum is taken as a limit. Hence one is never faced with the old problem of adding up an infinite number of infinitely small magnitudes that add up to nothing. A more sophisticated type of integration is the Lebesque method. Here it is made clear that the summation is taken as a limit over a set of magnitudes and not infinitesimal quantities or instants of time.

In my view, an instant of time is not a magnitude number but a boundary number and the difficulty arises from the confusion of the boundary number concept with the magnitude number concept. When measuring weight, we measure the object as a discrete whole, and represent the result on a scale of real numbers as a magnitude. Time however, is measured as an interval between boundaries. So now it is the boundaries that are the real numbers and the instants of time. But these instants are not magnitudes. Magnitude is the interval between the boundaries. It is measured by counting units of time between the boundary or limit points. So instants of time are limit points in a topological sense. Whether they exist or not is in my view an abstract type of argument. I am concerned only with the counting of the interval between the boundary points as time.

It is clear that time as a measurement is always a counting measurement. The number of "beats" is counted between the boundary events or instants of time. the resolution is determined by the frequency of the beats. Any measurement is uncertain to within the size of a beat. So we use very small beats to improve the resolution of time measurement. A clock is a device for measuring time, by counting the beats between the boundary events. The result is called an interval of time and is a magnitude measure like weight, or distance.

By this definition, there is no instant of time as a magnitude, because we can not measure time to less than a beat. So the beat is a quantum of time. In this sense there is no such thing as an instant of time but only its smallest measurable part, which is a beat. But we can in principle make the beats very small.

But can the beats be infinitely small? If one invokes quantum mechanics, then there is a principle adequate to handle the situation. It says that there is a limit to how small we can make the beats in a practical measurement of an event. But does this negate the idea of an instant of time as a boundary or limit measure for time interval?

I am not sure of this at all and I do not see how the arguments of Lynds have any real bearing on this as a profound problem of physics.

If one reads carefully, it is evident that the argument hinges upon the concept of measuring time "precisely". Lynds argues that it is impossible to do this measurement precisely. This is a misleading argument, since it is not necessary to measure an instant precisely, but only sufficiently. If Lynds were correct, then it would negate the technological success of stroboscopic photography. But we can make instantaneous photographs of bullets hitting things, effectively stopping time. So the issue is not, is there an instant of time, but the less exotic question of how small must we make the time resolution in order to make a sufficient measurement of the event in question. If Lynds were correct in his thesis, then all the sports records and races won according to the modern electronic methods must be rejected. But we will not reject them on the basis of his argument.

As a practical matter, the rational numbers are the numbers used in measurement, but the real numbers are the numbers used in the building of theories. We have to be cognizant of the differences. Lynds points out difficulties arising from this difference, but it should not be necessary for anyone who understands the fundamentals of physical measurement.